Twin-wire former

The invention relates to a twin-wire former for producing a fibrous web, in particular a paper, board or tissue web, from a fibrous suspension according to the preamble of claim 1.

A twin-wire former of this type is known from the German Published Specification DE 198 03 591 A1 (PB10656 DE) from the Applicant. The twin-wire former has two wire belts (lower wire and upper wire), which together form a twin-wire zone. In a first part of the twin-wire zone, in which the two wire belts run over a dewatering element in the form of a rotating forming roll, the two wire belts together form, directly at the forming roll, a wedge-like inlet gap, which picks up the fibrous stock suspension directly from a flowbox ("gap former"). In a second section of the twin-wire zone, the two wire belts with the fibrous web forming between them run steeply downward over further dewatering elements, for example over a plurality of forming foils and/or at least one forming shoe, preferably at an angle of 10° to 60° relative to an imaginary vertical plane. At the end of the second section of the twin-wire zone, the wire belts run over a deflection device and then over a separating device, which separates one of the wire belts from the forming fibrous web and from the other wire belt.

The disadvantage with this known twin-wire former is that, because of the relatively great forming roll diameter, which can assume a value for example between 1.5 and 2.5 m, it has a very large overall height. This large overall height leads to problems with regard to the height of the hall or crane, particularly in the case of rebuilds, and therefore to increased rebuilding costs and overhaul or operating costs.

It is therefore an object of the invention to improve a twin-wire former of the type mentioned at the beginning in such a way that the overall height is reduced such that, during rebuilds, no significant additional costs (rebuilding costs, overhaul costs, operating costs) arise and that, at relatively high machine speeds, complete secondary dewatering is made possible.

In the case of a first twin-wire former of the type mentioned at the beginning, this object is achieved, according to the invention, in that after the first deflection device, the two wire belts run upward at an angle relative to an imaginary second horizontal plane, in that the upper vertex of the second deflection device is located above the lower vertex of the first deflection device, and in that the angle between the flowbox and the imaginary first horizontal plane runs downward.

This achieves the advantage that the run of the two wire belts not only extends in a direction with regard to the overall height but, to some extent, is also of contrary design, and therefore the absolute overall height, in particular in the case of a rebuild, is reduced considerably. Furthermore, by arranging the flowbox at an angle that runs downward relative to the imaginary second horizontal plane, no increase in height is achieved, that is to say the flowbox does not increase the overall height of the twin-wire former, since as far as its components are concerned it is not oriented upward. In addition, on account of the deflection, the forming fibrous web is guided on an S-shaped path at an angle relative to an imaginary horizontal plane.

In further refinement of the first twin-wire former according to the invention, it is proposed that the upper vertex of the second deflection device be located at least 50 mm, preferably at least 100 mm, in

particular at least 200 mm, above the lower vertex of the first deflection device, and that the angle between the flowbox and the second imaginary horizontal plane assume a value between 0° and 45°, preferably between 0° and 30°.

In the case of a second twin-wire former of the type mentioned at the beginning, this object is achieved, according to the invention, in that after the first deflection device, the two wire belts run upward at an angle relative to an imaginary second horizontal plane, in that a felt removes the forming fibrous web from the wire belt at a pickup point which is located above the lower vertex of the first deflection device, and in that the pickup point is followed by a press unit, in which the forming fibrous web is guided first through a first, preferably double-felted press nip with a first press roll and a second press roll, after the first press nip is guided, with one of the felts, around the first press roll, is then transferred to a non-felted press roll in a second press nip and then runs through at least one further single-side-felted press nip.
In the case of this second twin-wire former according to the invention, as well, the result is the advantages mentioned in the case of the first embodiment. In addition, the position of the pickup point ensures that the latter does not contribute to an increase in the overall height, in particular in the case of a rebuild, but is located in the vertical area of the upstream twin-wire former that determines the overall height.

In further refinement of the second twin-wire former according to the invention, it is proposed that the pickup point be located at least 50 mm, preferably at least 100 mm, in particular at least 200 mm, above the lower vertex of the first deflection device.

According to the invention, the angle at which, after the deflection device, the two wire belts run upward relative to an imaginary second horizontal plane assumes a value between 10° and 90°, preferably between 25° and 40°, the desired achievement of the reduction in overall height being assisted positively.

In a further advantageous refinement of the invention, it is proposed that isobaric dewatering elements, as they are known, be arranged between the first deflection device and a separating device, between which the forming fibrous web runs, enclosed between the two wire belts. Therefore, for the forming fibrous web, the achievement of the best possible formation, that is to say the most uniform possible fiber distribution is ensured, and this with the greatest possible dewatering performance and with the lowest possible energy consumption during the web formation operation. Advantageously, at least one stationary isobaric dewatering element is arranged on the one wire belt and at least one isobaric dewatering element is arranged on the other wire belt, and can be set resiliently against the wire belt by means of a selectable force. The isobaric dewatering elements can therefore be adapted in a straightforward, time-saving and cost-effective way to various operating conditions and to various fibrous suspensions.
Furthermore, the isobaric dewatering elements are designed as plates or plate segments, since these shapes can be produced and operated cost-effectively.

In a further embodiment of the invention, provision is made for at least one flat suction element to be arranged after the separating device, acting on the wire belt which carries the forming fibrous web. In this way, the dewatering and formation of the forming fibrous web is additionally positively assisted.

In an advantageous embodiment of the invention, provision is made for a deflection of the wire belt to follow the second deflection device, in such a way that the wire belt subsequently runs downward at an angle of less than 60°, preferably less than 40°, in particular less than 25°, relative to an imaginary second vertical plane.

In an alternative advantageous refinement, the deflection of the wire belt is carried out in such a way that the wire belt subsequently runs substantially horizontally, in a further refinement, a further sheet forming device, preferably a hybrid former, being arranged after the second deflection device. The wire belt advantageously runs at least 50 mm, preferably at least 100 mm, above the lower vertex of the first deflection device.

The second deflection device is preferably a suction roll, a shoe with foils or a shoe with foils and with applied vacuum, since these aforementioned elements belong to the prior art, and therefore possess increased functional reliability and low procurement costs, and possibly also low operating costs.

In a further embodiment of the invention, provision is made for the distance between the lower vertex of the first deflection device and the upper vertex of the second deflection device to have a value between 1 and 8 m, preferably between 3 and 6 m.

In this further embodiment, it is again advantageous that the overall height is reduced in such a way that, in the case of rebuilds, no substantial additional costs (rebuilding costs, overhaul costs, operating costs) arise.

With regard to constructional and economic aspects, it is advantageous if the first deflection device is a

closed roll, an open roll or an open roll with applied vacuum.

Furthermore, with regard to constructional and economic aspects, it is advantageous if the separating device is designed as a suction separator and/or a vacuum shoe.

In addition, it is advantageous with regard to constructional and economic aspects if the forming roll which, according to the invention, advantageously has a diameter of greater than 1200 mm, preferably greater than 1635 mm, in particular greater than 1760 mm, is designed as an open roll, and the open forming roll is closed by means of a grille or honeycomb structure or is a suction roll.

These elements just mentioned belong to the known prior art, and therefore possess an increased functional reliability and low procurement costs, possibly also low operating costs.

With regard to a low overall height of the twin-wire former, on the one hand, and a minimum number of components in the twin-wire former, on the other hand, it is beneficial if the forming roll has a dewatering capacity which has a value of at least 50%, preferably of at least 65%, of the total dewatering capacity of the twin-wire former. The components for the remaining dewatering, together with the associated overall height, can therefore turn out to be considerably lower than is usual.

It is technologically advantageous if the dewatering on the deflection roll is greater than on the other rolls, that is to say the roll diameter of the deflection roll is greater than the roll diameter of the forming roll and/or the roll diameter of the suction roll.

Both from constructional and from financial aspects, it is advantageous if the twin-wire former has an overall

height in a range from 2 to 8 m, preferably from 3 to 6 m.

The twin-wire former according to the invention is also very well suited to the application in a former rebuild, since in this case constructional conditions which are generally present, for example the dimensions of the whole, have to be taken into account and, as a result, the former rebuild should not entail any further space requirement, for example as a result of an increased overall height of the twin-wire former to be installed.

It goes without saying that the features of the invention mentioned above and still to be explained below can be used not only in the respectively specified combination but also in other combinations or on their own, without leaving the scope of the invention.

Further features and advantages of the invention emerge from the subclaims and the following description of preferred exemplary embodiments, making reference to the drawing, in which:

Figure 1 shows a schematic and section side view of a first advantageous embodiment of the twin-wire former according to the invention;

Figure 2 shows a schematic and section side view of a second advantageous embodiment of the twin-wire former according to the invention; and

Figures 3 to 6 show schematic and section side views of further advantageous embodiments of the twin-wire former according to the invention.

The twin-wire former 1 illustrated in schematic and section side view in figure 1 comprises two endless wire belts, namely a lower wire 2 and an upper wire 3, which carry a forming fibrous web 4 centrally. These two wire belts 2, 3 together form a twin-wire zone 5, running over a dewatering element 6 in the form of a rotating forming roll 7 in a first section in the twin-wire zone 5 and together forming a wedge-like inlet gap 8 which picks up the fibrous suspension directly from a flowbox 9 fitted at an angle δ relative to an imaginary first horizontal plane H1 ("gap former"). The flowbox 9, illustrated schematically, can of course also be equipped as a multi-layer flowbox and/or as a flowbox with controllable-section dilution water technology ("Module Jet" system). In a second section of the twin-wire zone 5, the two wire belts 2, 3 with the fibrous web 4 forming between them run downward over a plurality of dewatering elements 6 (not specifically illustrated), such as a forming shoe, a plurality of forming foils or a plurality of isobaric dewatering elements, at an angle α of 10° to 60° relative to an imaginary first vertical plane V1. At the end of the second section of the twin-wire zone 5, the two wire belts 2, 3 run over a first deflection device 10 with a lower vertex 10.SU and then over a separating device 11 which acts over the machine width and in the area of which the upper wire 3 is led away from the forming fibrous web 4 and the lower wire 2. Of course, in the case of a different design of the twin-wire former 1, it is also possible for the lower wire 2 to be separated from the forming fibrous web 4 and the upper wire 3. The separated upper wire runs on to a guide roll 12 and from there, directly or indirectly, over further rolls back to the wedge-like inlet gap 8. After the separating device 11, a second deflection device 15 with an upper vertex 15.SO is arranged, and deflects the lower wire 2 which carries the forming fibrous web 4. After that, the lower wire 2 together with the

forming fibrous web 4 runs over a suction roll 13 to a pickup point S_p of a pickup roll 14, on which the pickup roll 14 removes the fibrous web 4 from the lower wire 2 and the fibrous web 4 is transported to further manufacturing stages in the paper, board or tissue machine. The lower wire runs on to a guide roll 12 and from there, indirectly over further rolls, back to the wedge-like inlet gap 8.

According to the invention, in the first advantageous embodiment of the twin-wire former 1 according to the invention, provision is then made that, after the first deflection device 10, the two wire belts 2, 3 run upward at an angle β relative to an imaginary second horizontal plane H2 in such a way that the upper vertex 15.SO of the second deflection device 15 is located above the lower vertex 10.SU of the first deflection device, and that the angle δ runs downward relative to the imaginary first horizontal plane H1. In this case, the angle δ runs downward in the clockwise direction in figure 1 in relation to the imaginary first horizontal plane H1.

Furthermore, the upper vertex 15.SO of the second deflection device 15 is located at least 50 mm, preferably at least 100 mm, in particular at least 200 mm, above the lower vertex 10.SU of the first deflection device 10 and, according to the invention, the angle δ assumes a value between 0° and 45°, preferably between 0° and 30°.

In addition, the angle β, at which the two wire belts 2, 3 run upward relative to an imaginary second horizontal plane H2 after the first deflection device 10, assumes a value between 10° and 90°, preferably between 25° and 40°.

In addition, the invention provides for a deflection of the wire belt 2 to be carried out at the second deflection device 15 in such a way that the wire belt 2 then runs downward at an angle γ of less than 60°,

preferably less than 40°, in particular less than 25°, relative to an imaginary second vertical plane V2.

The forming roll 7 in figure 1 has a diameter D7 of greater than 1 200 mm, preferably greater than 1 635 mm, in particular greater than 1 760 mm, and is designed as a suction roll; however, it can also be designed as an open roll, it being possible for the open roll in turn to be closed by means of a grille or honeycomb structure.

Furthermore, the forming roll 7 has a dewatering capacity which has a value of at least 50%, preferably of at least 65%, of the total dewatering capacity of the twin-wire former.

The first deflection device 10 is a closed roll 16; however, it can also be an open roll or an open roll with applied vacuum. Furthermore, in figure 1 the separating device 11 is designed as a suction separator 17; however, it can also be designed as a vacuum shoe.

The second deflection device 14 is designed as a suction roll; however, it can also be designed as a shoe with foils or a shoe with foils and with applied vacuum.

The distance A between the lower vertex 10.SU of the first deflection device 10 and the upper vertex 15.SO of the second deflection device 15 assumes a value between 1 and 8 m, preferably between 3 and 6 m. The twin-wire former 1 preferably assumes an overall height H in a range from 2 to 8 m, preferably from 3 to 6 m.

The twin-wire former 1 illustrated in schematic and section side view in figure 2 in principle resembles the twin-wire former of figure 1; with regard to the further description of the twin-wire former 1, reference is made to the description of figure 1.

According to the invention, in the second advantageous embodiment of the twin-wire former 1 according to the invention, provision is now made for the two wire belts 2, 3, after the first deflection device 10, to run

upward at an angle β relative to an imaginary second horizontal plane H2, for a felt 23 to remove the forming fibrous web 4 from the wire belt 2 at a pickup point S_p, which is located above the lower vertex 10.SU of the first deflection device 10, and for the pickup point S_p to be followed by a press unit 24, in which the forming fibrous web 4 is guided first through a first, preferably double-felted press nip 25 with a first press roll 26 and a second press roll 27, after the first press nip 25 is guided, with one of the felts 23, around the first press roll 26, is then transferred to a non-felted press roll 29 in a second press nip 28, and then runs through at least one further single-side-felted press nip 30, which is formed by the non-felted press roll 29 and a suction roll 31.

Furthermore, the invention further provides for the pickup point S_p to be located at least 50 mm, preferably at least 100 mm, in particular at least 200 mm, above the lower vertex 10.SU of the first deflection device 10.

The press unit 24 illustrated in figure 2 is taken as an extract from the German Published Specification DE 196 54 325 A1 (PC10453 DE). In addition, the German Published Specification DE 197 44 341 A1 (PC10623 DE) discloses further-reaching embodiments of an appropriate press unit. The descriptions of these two aforementioned published specifications are hereby in full made the subject of the present description.

The press unit 24 in a further embodiment can further be followed by at least one further press unit which is not illustrated but is included in the prior art, the combination of individual press units also being possible. The design of the press unit 24 is therefore not restricted to the design of the same illustrated and described.

The angle δ runs downward in the counterclockwise direction in relation to the imaginary first horizontal plane H1 in figure 2.

A further advantageous embodiment of the twin-wire former 1 according to the invention is illustrated in schematic and section side view in figure 3. This twin-wire former 1 possesses substantially the same construction with regard to the twin-wire zone 5 as the twin-wire former of figure 1.

According to the invention, however, isobaric dewatering elements 18, 19, as they are known, are arranged between the first deflection device 10 and the separating device 11 of this twin-wire former 1, between which the forming fibrous web 4 runs, enclosed between the two wire belts 2, 3. Isobaric dewatering elements 18 of this type are described in the German Published Specification DE 197 33 316 A1 (PB10569 DE) of the Applicant; the content of this aforementioned published specification is hereby made the subject of this description. Arranged on the upper wire 3 is a stationary isobaric dewatering element 18, and at least one isobaric dewatering element 19 is arranged on the lower wire 2 and can be set resiliently against the lower wire 2 by means of a selectable force. It goes without saying that the isobaric dewatering elements 18, 19 can also act on the wire belts 2, 3 in the converse arrangement. The isobaric dewatering elements 18, 19 are designed as plates or plate segments.

Furthermore, three flat suction elements 20 are arranged after the separating device 11 and act on the lower wire 2, which carries the forming fibrous web 4.

A further advantageous embodiment of the twin-wire former 1 according to the invention is illustrated in schematic and section side view in figure 4. This twin-wire former 1 has substantially the same construction with regard to the twin-wire zone 5 as the twin-wire former of figure 1.

According to the invention, the second deflection device 15 is designed as a shoe 21. The deflection is

carried out in such a way that the lower wire 2 subsequently runs substantially horizontally. Arranged after the second deflection device 15 is a further sheet forming device 22, which produces a further fibrous web 4.1. The two fibrous webs 4, 4.1 are couched by means of known devices and transported to further manufacturing stages in the paper, board or tissue machine. Since the further sheet forming device is designed as a former belonging to the known prior art, preferably a hybrid former, it will not be discussed specifically; instead, reference is made to the known prior art.

A further advantageous embodiment of the twin-wire former 1 according to the invention is shown in schematic and section side view in figure 5.
As distinct from the other figures, according to the invention, the angle β assumes a value of 90°, so that the twin-wire zone 5 runs vertically upward after the first deflection device 10. This results in the advantage of improved removal of water without rewetting and without the use of vacuum. After the separation of the wires, the lower wire 2, together with the forming fibrous web 4, is guided over a suction roll 13 into a horizontal position. The lower wire 2 together with the forming fibrous web 4 then runs over three flat suction elements 20, which act on the lower wire 2, which carries the forming fibrous web 4.

The twin-wire former 1 illustrated in schematic and section side view in figure 6 is designed as a hybrid former, known per se, the upper wire 3 of the hybrid former simultaneously forming the fourdrinier wire of a top-fitted fourdrinier wire former with a top fitted hybrid former. With regard to the S-shaped web guidance and the fitting of dewatering elements 6, in particular

of isobaric dewatering elements, reference is made to the above embodiments.

In summary, it is to be recorded that the invention provides a twin-wire former of the type mentioned at the beginning of which the overall height is reduced in such a way that, in the case of rebuilds, no significant additional costs (rebuilding costs, overhaul costs, operating costs) arise, and which permit complete secondary dewatering at relatively high machine speeds.

List of reference symbols

1	Twin-wire former
2	Lower wire (wire belt)
3	Upper wire (wire belt)
4, 4.1	Fibrous web
5	Twin-wire zone
6	Dewatering element
7	Forming roll
8	Inlet gap
9	Flowbox
10	First deflection device
11	Separating device
12	Guide roll
13	Suction roll
14	Pickup roll
15	Second deflection device
16	Roll
17	Suction separator
18, 19	Isobaric dewatering element
20	Flat suction element
21	Shoe
22	Sheet forming device
23	Felt
S_p	Pickup point
24	Press unit
25	Press nip (preferably double-felted)
26	First press roll
27	Second press roll
28	Second press nip
29	Press roll (nonfelted)
30	Press nip (felted on one side)
31	Suction roll

A	Distance
D7,D13,D15	Roll diameter
H	Overall height
H1	First horizontal plane

H2	Second horizontal plane
10.SU	Lower vertex
15.SO	Upper vertex
V1	First vertical plane
V2	Second vertical plane
$\alpha,\beta,\gamma,\delta$	Angle